



Dispersion and Stretching in a 3D Porous media

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Dispersion & stretching in 3D porous media

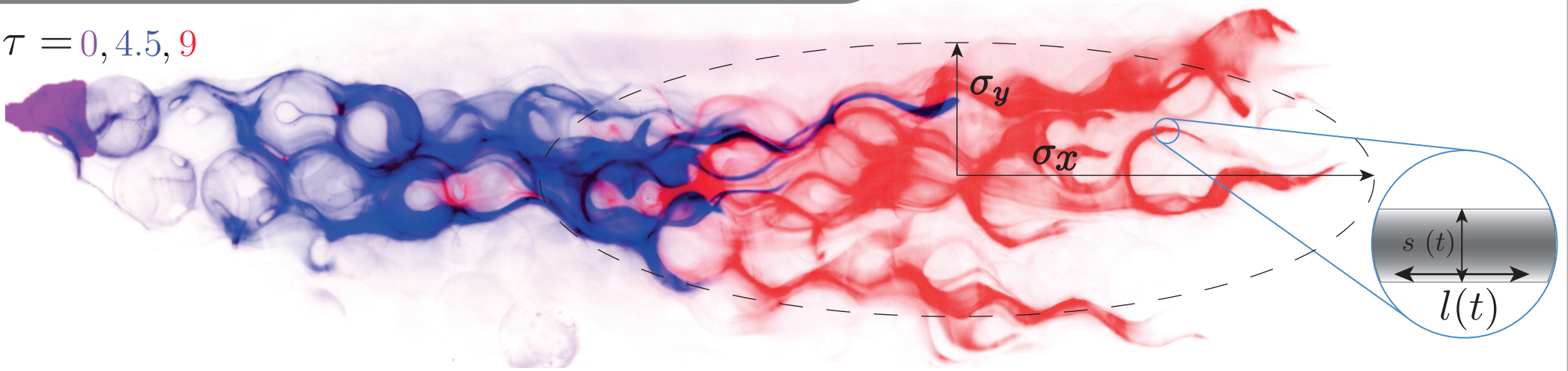
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Mixing of a blob of dye in a porous media

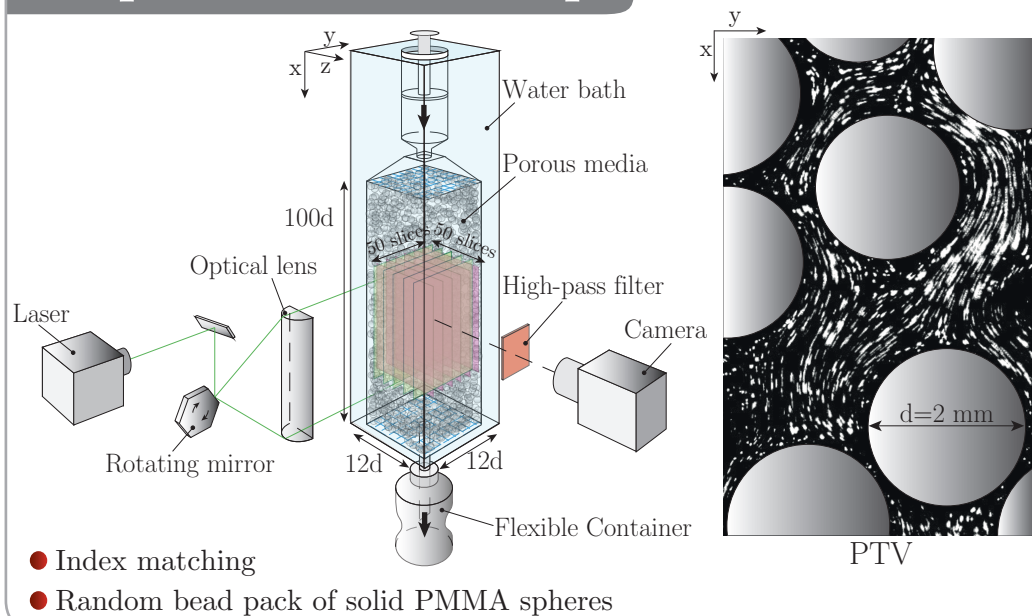
$t/\tau = 0, 4.5, 9$



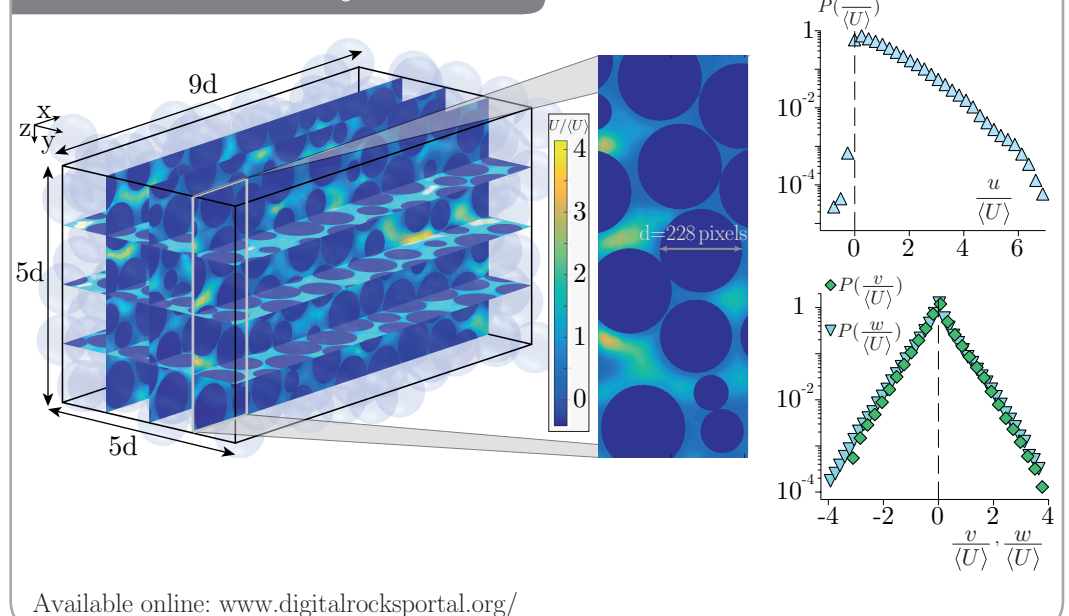
A blob of dye advected in a 3D porous medium disperses in the surrounding medium while deforming into a set of elongated lamellae. We measure the 3D velocity field to characterize the dynamics of dispersion and stretching, thus investigating :

- What is the distribution of stretching $\rho (= \frac{l(t)}{l_0})$ in a 3D porous medium ?
- How is the velocity field distribution related to dispersion ?

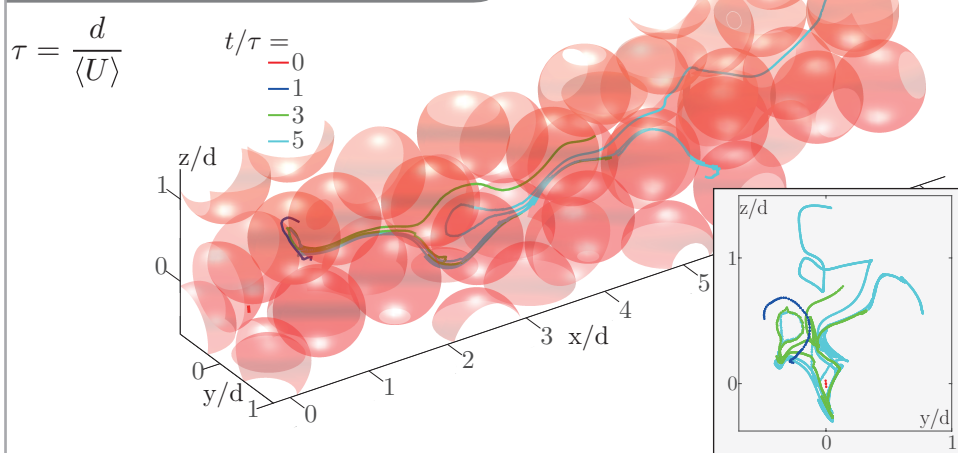
Experimental set-up



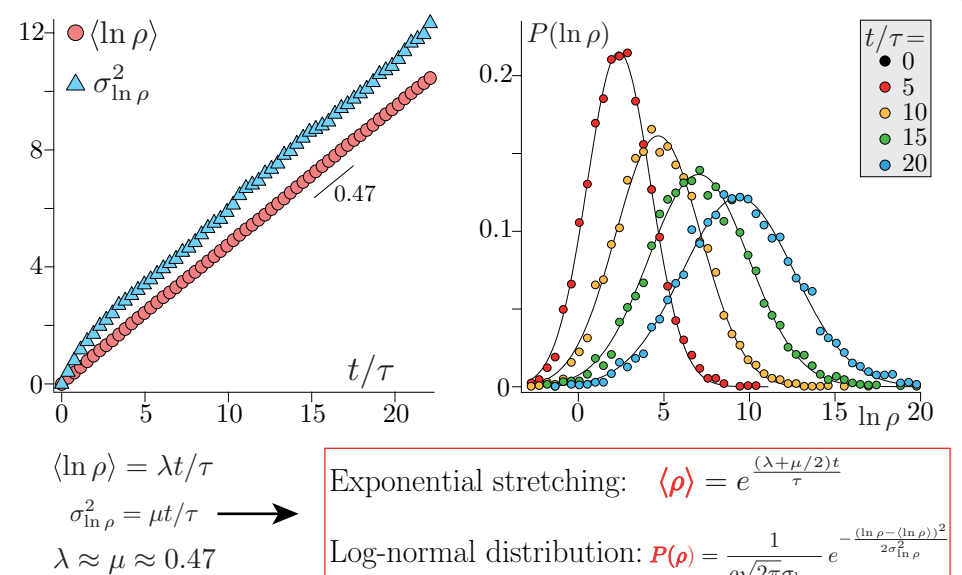
3D Velocity field



Stretching laws



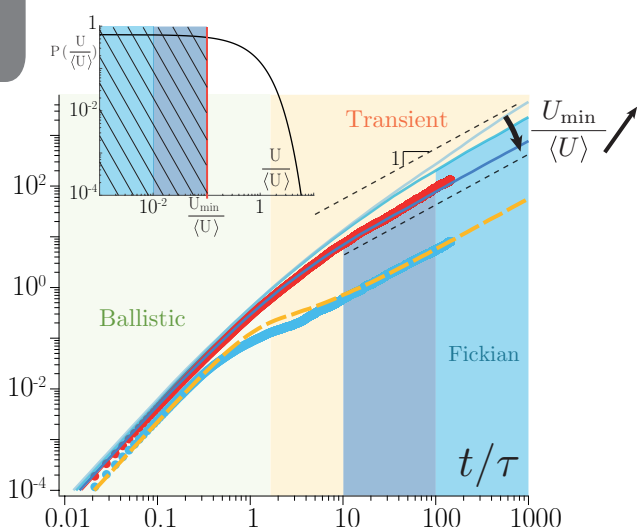
Evolution of a material line advected numerically in the 3D experimental velocity field



Dispersion

σ_x^2/d^2	CTRW	$U_{\min}/\langle U \rangle$	t_F/τ
• Experiments	—	0	∞
	—	0.01	100
	—	0.1	10

σ_y^2/d^2	CTRW with anti-correlation
• Experiments	—

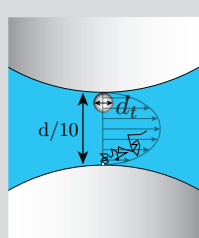


- Continuous Time Random Walk for a flat velocity distribution leads to **anomalous** dispersion

$$\rightarrow \frac{\sigma_x^2}{d^2} \sim \frac{\log(t/\tau)t}{\tau}$$

- Minimum cut-off velocity in real system partially precludes the velocity distribution, leading to :

Origin of a minimum cut-off velocity :



Tracer Finite size:
 $\frac{U_{\min}}{\langle U \rangle} \approx \frac{10d_t}{d}$

Tracer Finite diffusion:
 $\frac{U_{\min}}{\langle U \rangle} \approx \left(\frac{10^2}{Pe}\right)^{1/3}$

Fickian behavior beyond: $t_F = d/U_{\min}$

$$\rightarrow \frac{\sigma_x^2(t)}{d^2} = \ln \left(\frac{\langle U \rangle}{U_{\min}} \right) \frac{\langle v_x \rangle^2 t}{\langle U \rangle^2 \tau}$$

$$\rightarrow \frac{\sigma_y^2(t)}{d^2} = \ln \left(\frac{\langle U \rangle}{U_{\min}} \right) (1 - p) \frac{\langle v_y \rangle^2 t}{\langle U \rangle^2 \tau}$$